Landsat Science Team Meeting, Jan. 8-10, 2008

Building Consistent Time-series Mid-resolution Data Set from Landsat and Landsat-like Data

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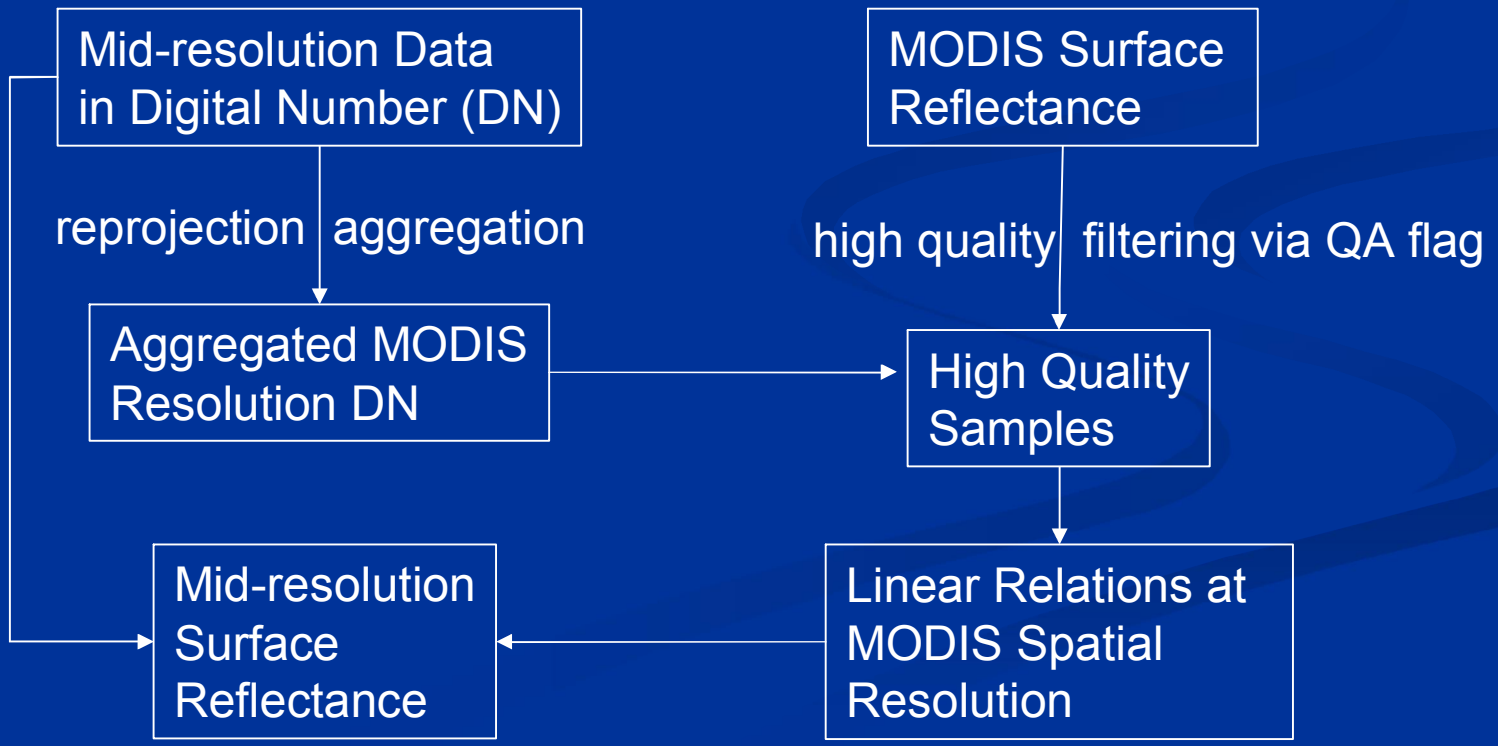
Background

- A more robust land monitoring system would combine observations from multiple, international sensors – this will offer more frequent observations
- Typical mid-resolution (10-60m) satellite data includes

  Landsat MSS, TM, ETM+
  SPOT HRV, HTVIR, HRG
  TERRA ASTER
  CBERS CCD
  IRS-P6 LISS, AWiFS
- Consistent data set should be processed in surface reflectance. However, even with perfect calibration and atmospheric correction, direct comparison of surface reflectance from different sensors are still limited by viewing and illumination geometries, spectral band response function and geolocation accuracy and resampling approaches.
- We correct mid-resolution satellite data (DN) to a consistent data stream (SR) using standard surface reflectance as a reference data set.

General Empirical Relation Model (GERM)

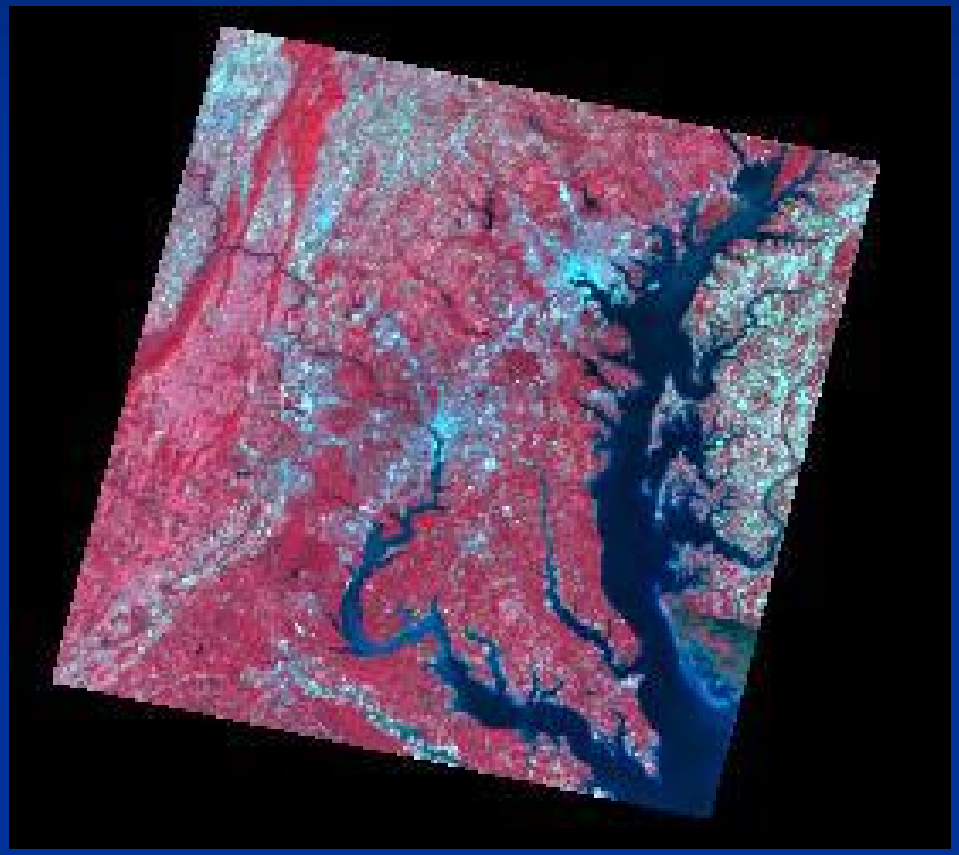
GERM approach converts sensor digital number (DN) to surface reflectance directly using MODIS products as reference data sets.



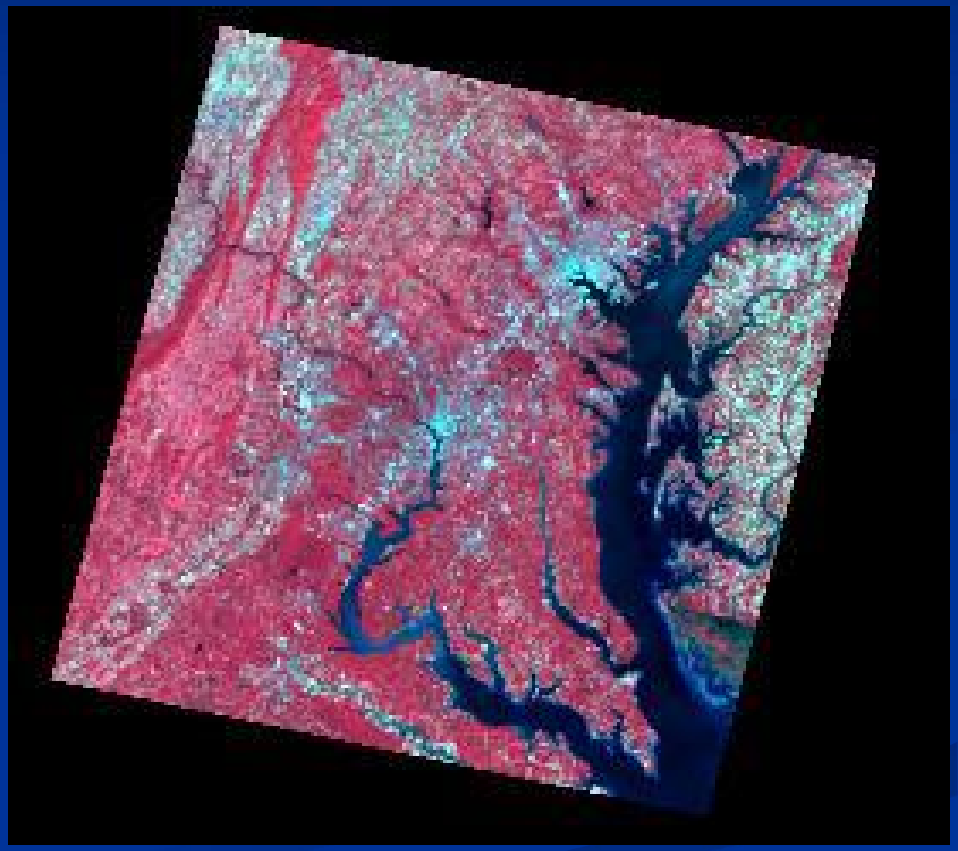
MODIS Inputs

- 500m daily surface reflectance
  - MOD09GHK (reflectance)
  - MOD09GST (quality and cloud state)
- 16-day 1km Nadir BRDF-adjusted Reflectance (NBAR)
  - MOD43B4 / MCD43B4
  - 500m in collection 5 (8-day overlap rolling)
- Daily NBAR use MODIS BRDF parameters and daily bi-directional reflectance (magnitude inversion approach)

Compare GERM Approach to Physical Approach Using Same ETM+ Data



From GERM (empirical)



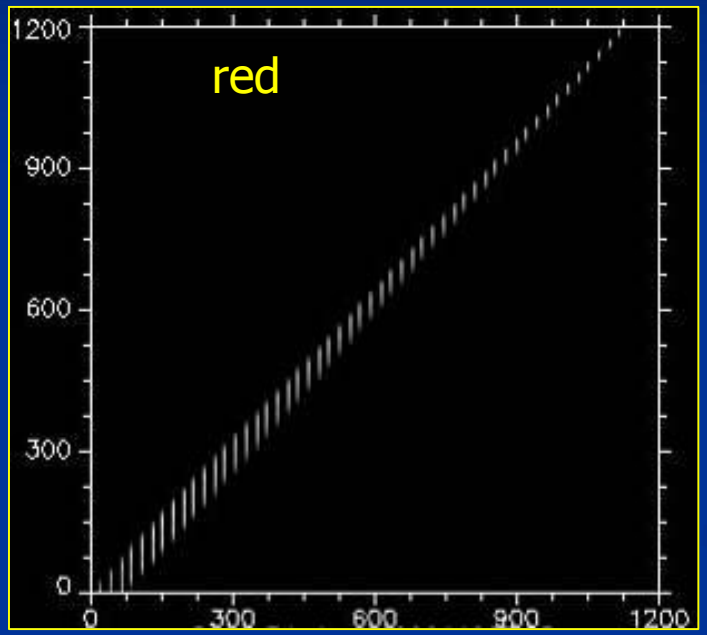
From LEDAPS (physical)

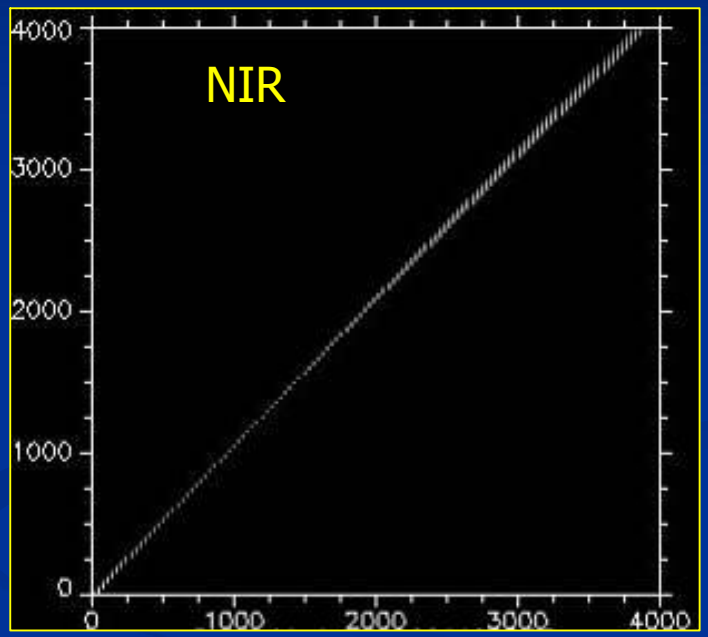
(Landsat ETM+ surface reflectance, p15r33, Oct. 15, 2001)

MODIS-like Surface Reflectance

LEDAPS

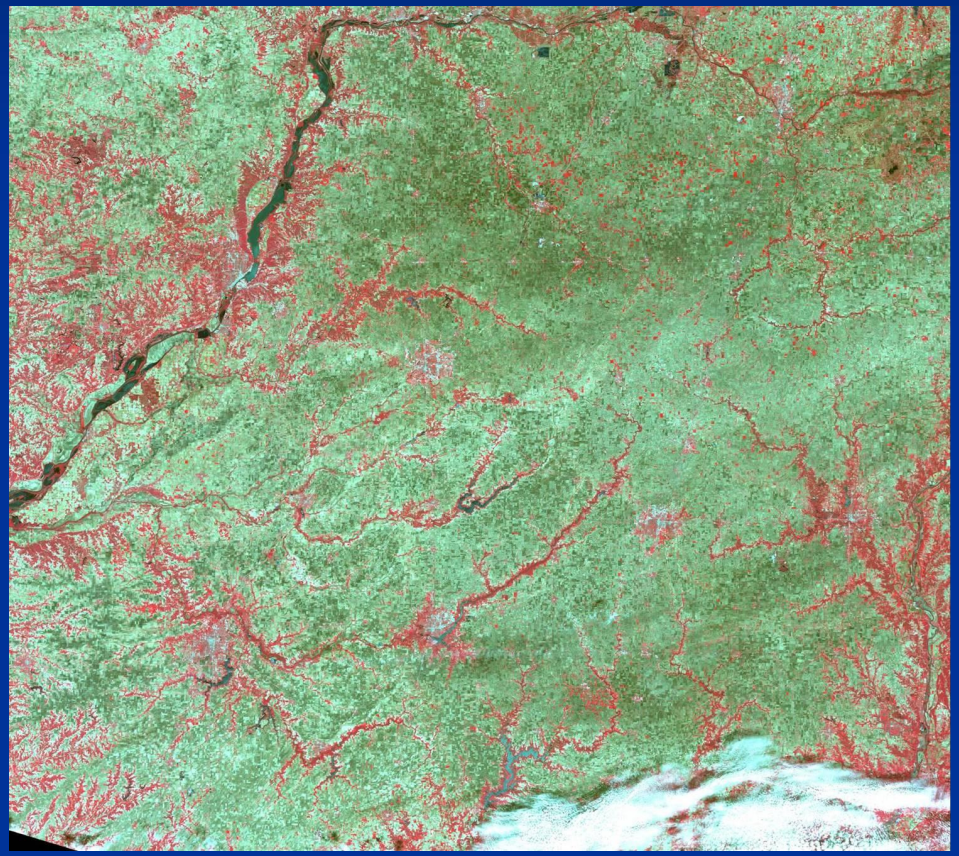
GERM



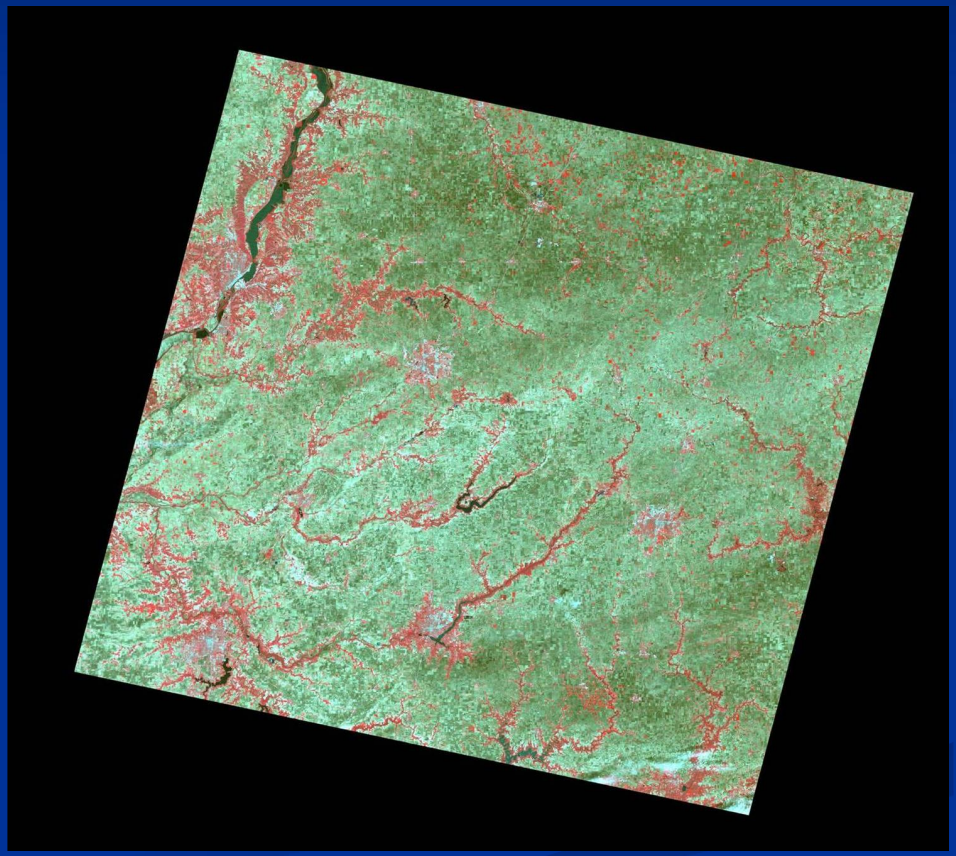


Note that MODIS-like surface reflectance may be converted to the Landsat-like surface reflectance using band conversion coefficients and thus consistent with historical Landsat data record

Compare SR from Different Sensors Using Same GERM Approach

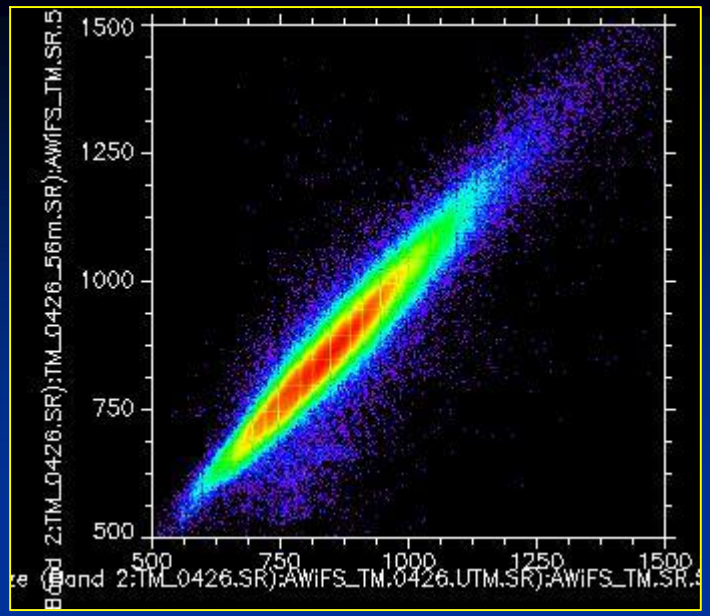


AWiFS Surface Reflectance

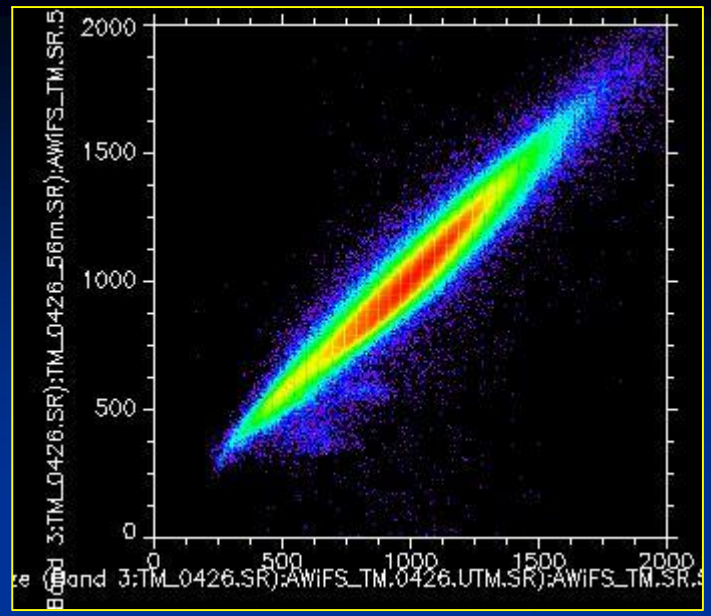


TM Surface Reflectance

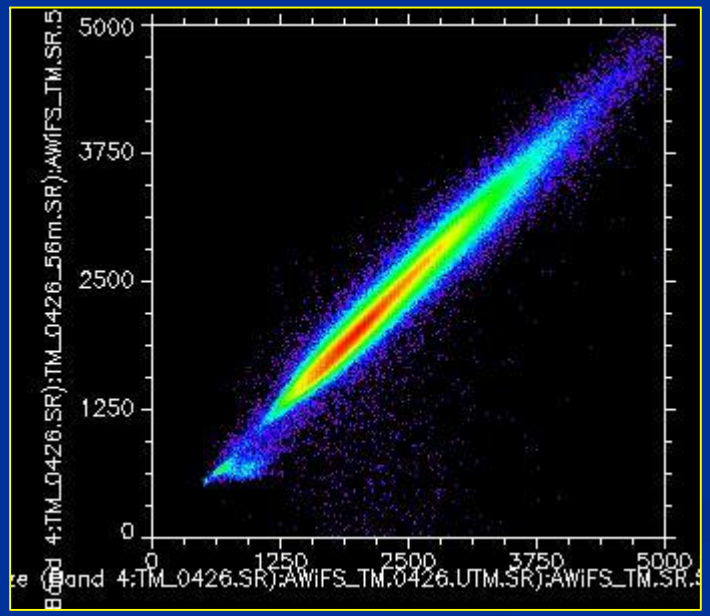
(April 26, 2006, both used MODIS daily NBAR as reference)



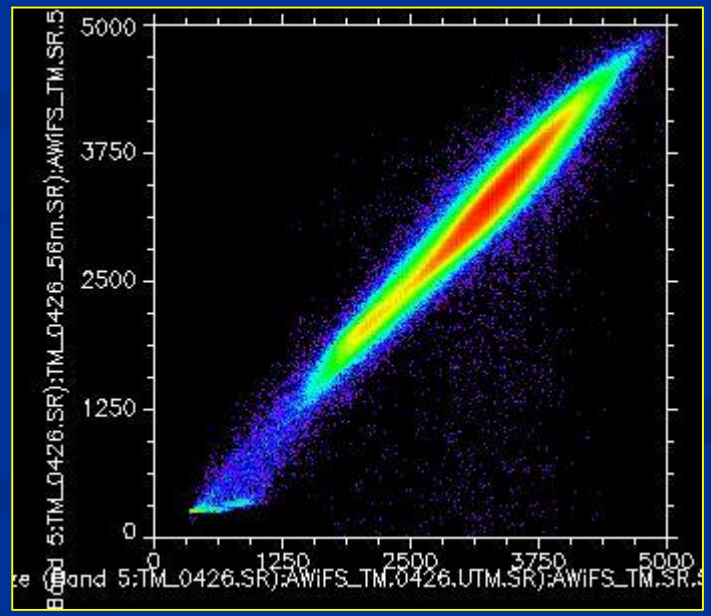
Green (B2)



Red (B3)



NIR (B4)

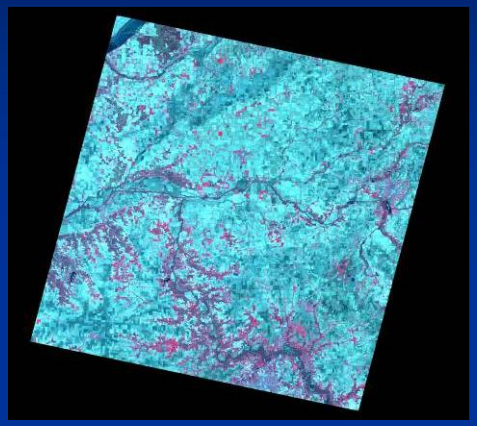


MIR (B5)

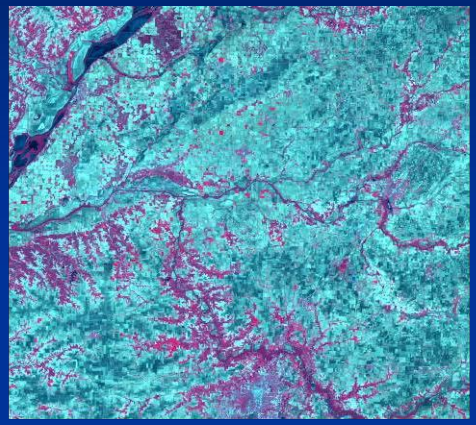
TM

AWiFS

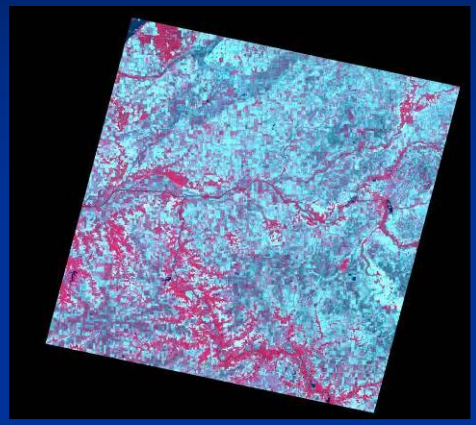
Combining Data from Multiple Sensors



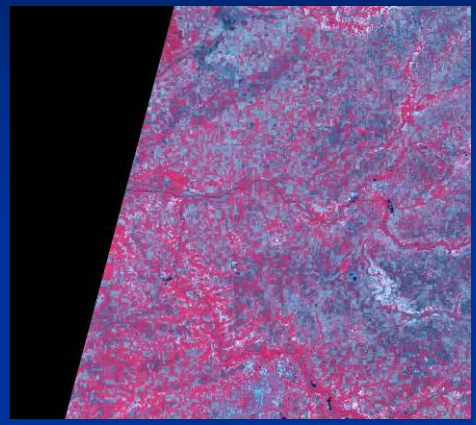
(a) 4/18/06, ASTER



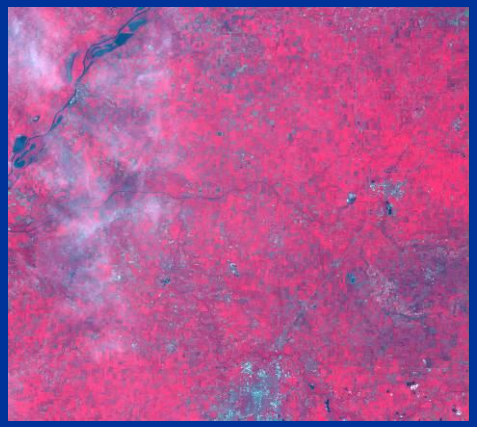
(b) 4/26/06, AWiFS



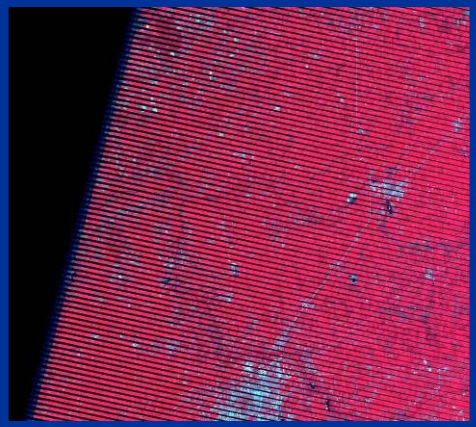
(c) 6/5/06, ASTER



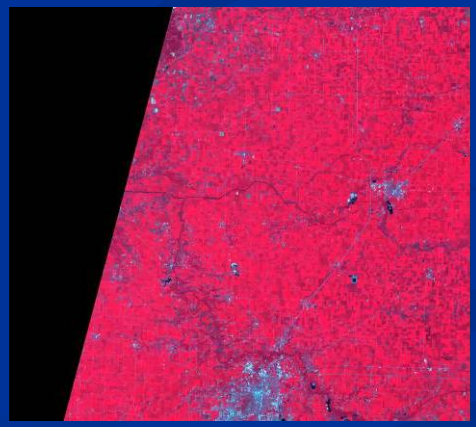
(d) 6/13/06, TM



(e) 7/7/06, AWiFS



(f) 7/23/06, ETM+



(g) 7/31/06, TM

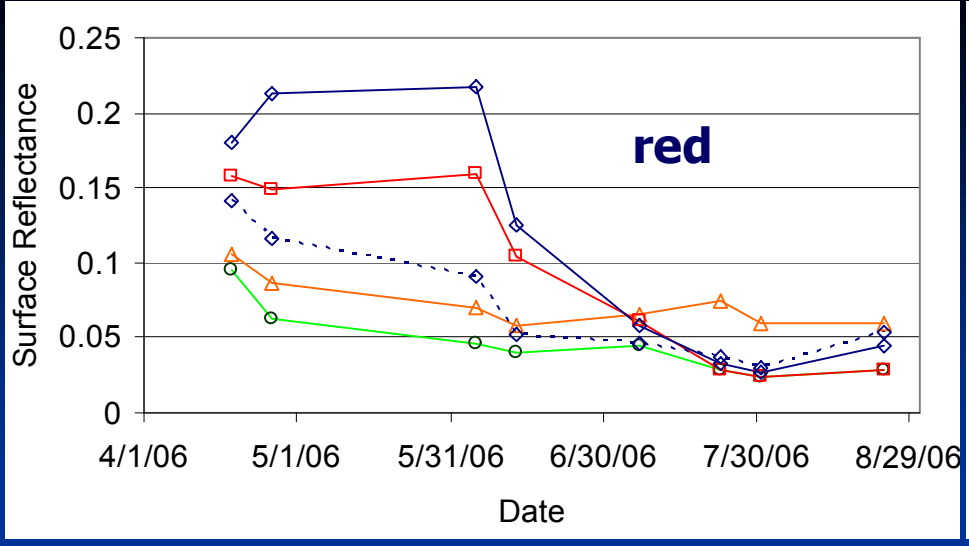
(h) 8/24/06, AWiFS

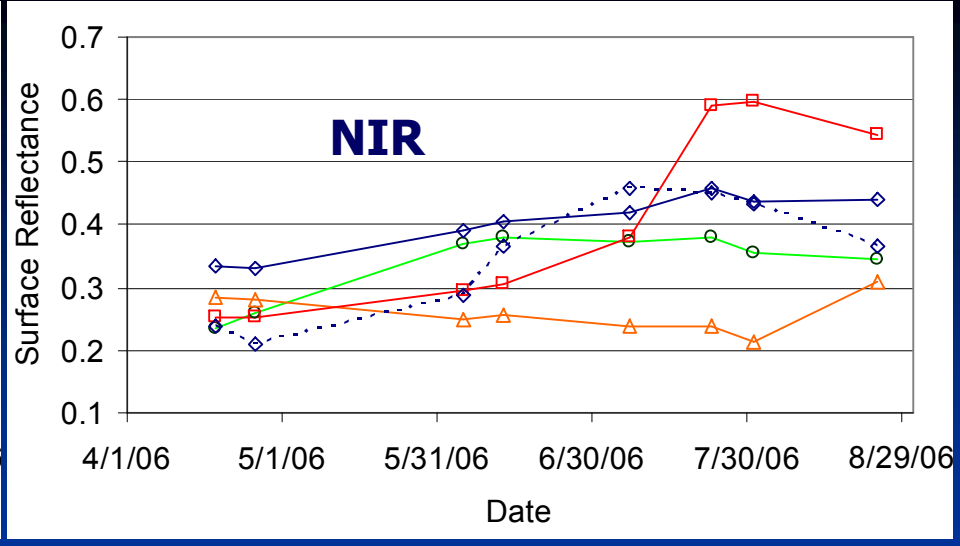
Four Typical Surface Types

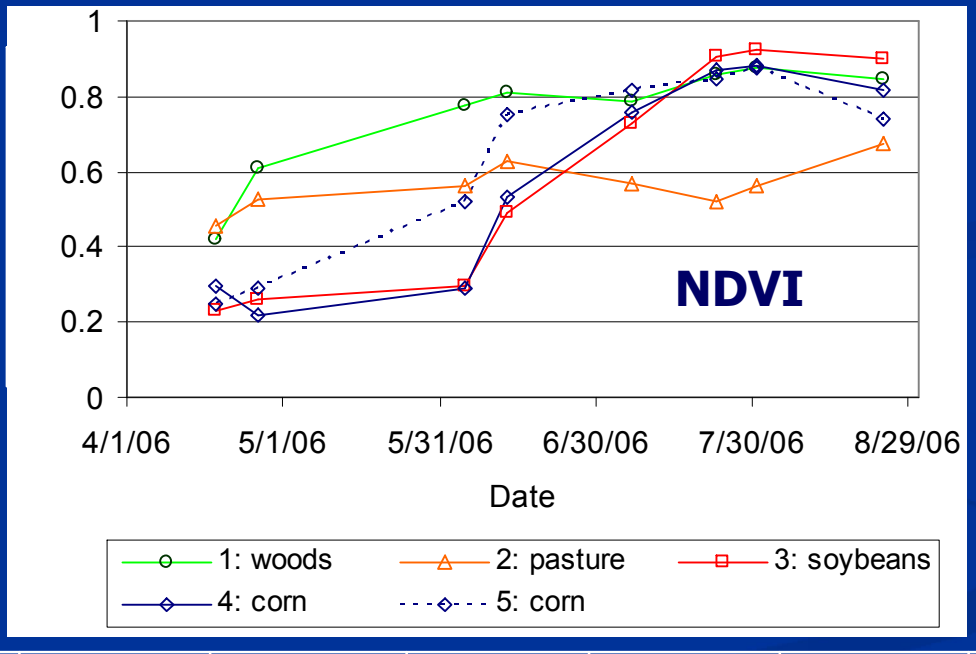
Samples Location
(ASTER, June 5, 2006)

USDA 2006 Crop Data Layer

Natural Veg.	1: woods	2: pasture	
Crops	3: soybeans	4: corn	5: corn







Date	4/18/06	4/26/06	6/5/06	6/13/06	7/7/06	7/23/06	7/31/06	8/24/06
Sensors	ASTER	AWiFS	ASTER	TM	AWiFS	ETM+	TM	AWiFS
MODIS	C1	C3	C1	C3	C1	C1	C3	C1

Summary

- GERM approach is a one step conversion – easy to implement
- Produces the MODIS compatible products
  - A consistent data set from multiple sensors
  - MODIS-like surface reflectance may be used as a direct input to the MODIS algorithms and thus retrieve biophysical parameters
- MODIS is an appropriate reference since it provides
  - Similar spectral coverage to most Landsat-like sensors
  - Daily global coverage
  - Easy and free online access
  - Pixel-level quality control
- Further improvements
  - Dealing with spatial variations in aerosol loading
  - Accurate automatic detection on cloud mask
  - Good samples selection and accumulation

Automatic Registration and Orthorectification Package (AROP)

- Provides automatic processing in precise registration, orthorectification or BOTH
- Handles different sensor data in different spatial resolutions and projections using one standard image as base (e.g. GeoCover in 28.5m or 30.0m, UTM)
- Allows selecting output in different spatial resolution by using various resampling or aggregation approaches
- Has been tested using MSS, TM, ETM+ (L1G), ASTER, CBERS, AWiFS with average errors < 1-2 pixel (control points RMSE < 0.5 pixel)
- Tentative release date: May 2008

Landsat 1
MSS
57m->57m

11-16-1973

Landsat 4
MSS
57m->57m

05-08-1984

Landsat 5
TM
28.5m->57m

08-03-1995

Landsat 7
ETM+
28.5m->57m

03-31-2005